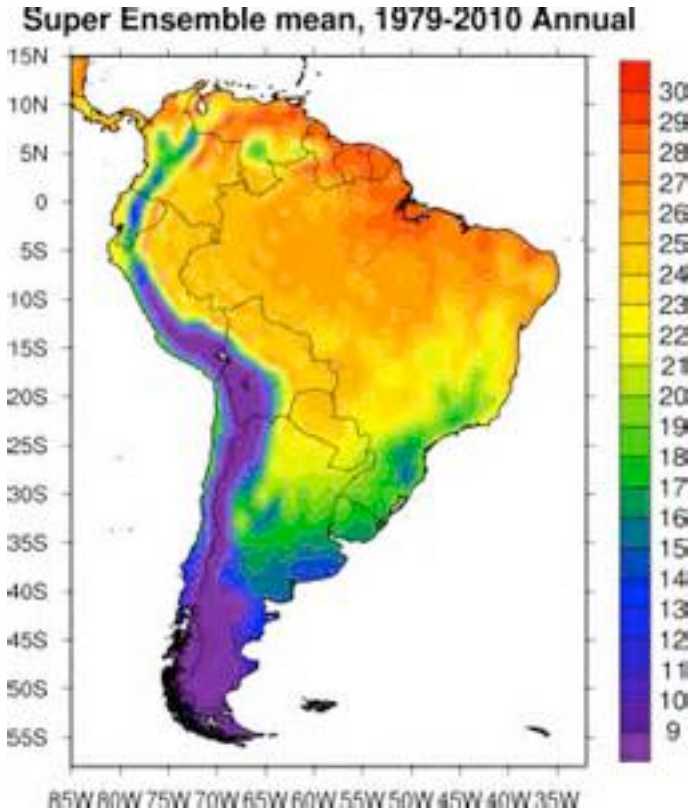
Climate Variability, Hydrology, and Flooding

Overview of the Climate System, Climate Variability and Change over South America



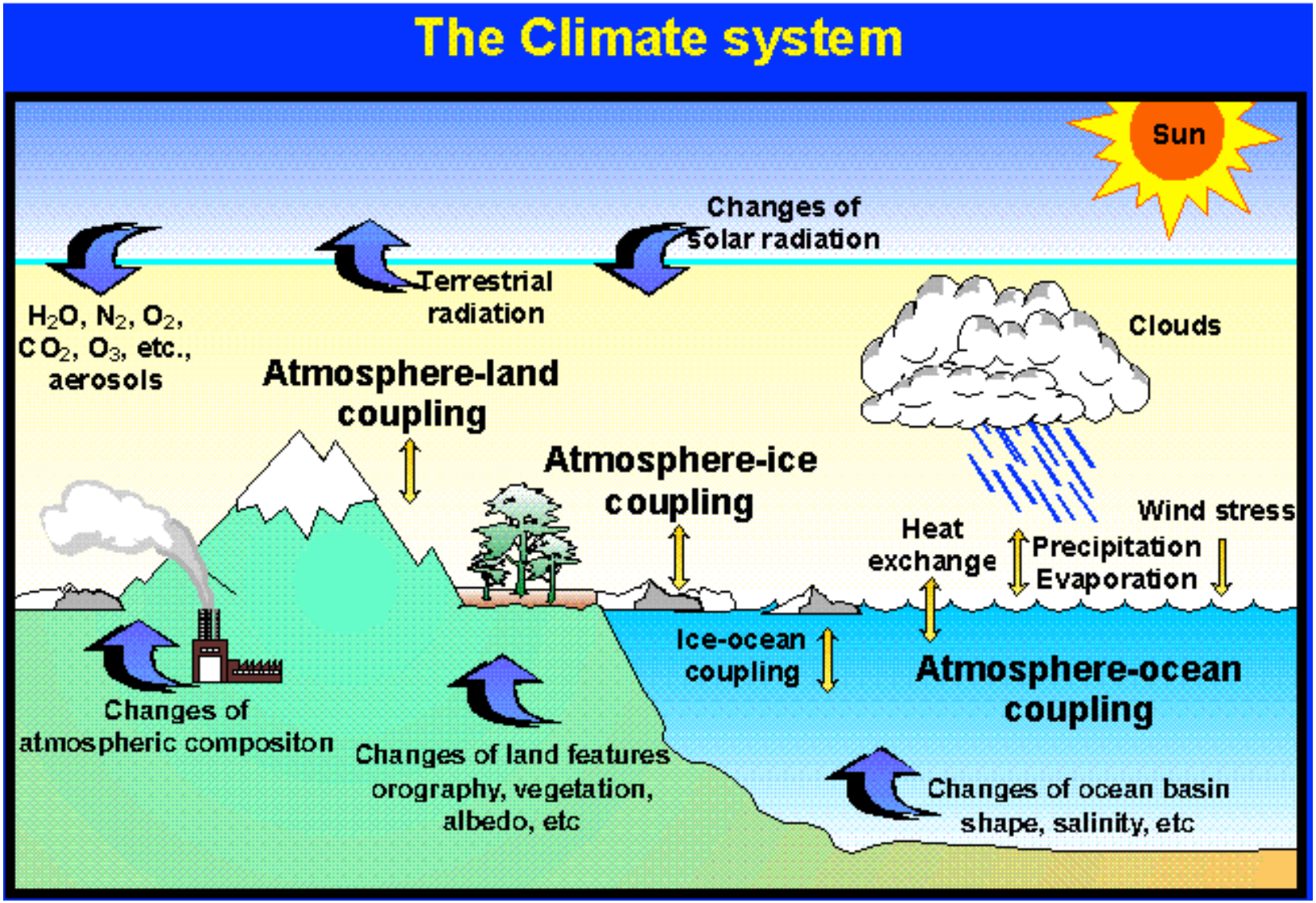
Objective

To Introduce the Climate System and Review Climate Impacts on South America

Outline

- Earth's Climate System
  What is Weather, Climate, Climate Variability, and Climate Change?
- Climate Variability and Change Impacts on Hydrologic Conditions over South America
- How can NASA Remote Sensing Observations help?

Earth’s Climate System



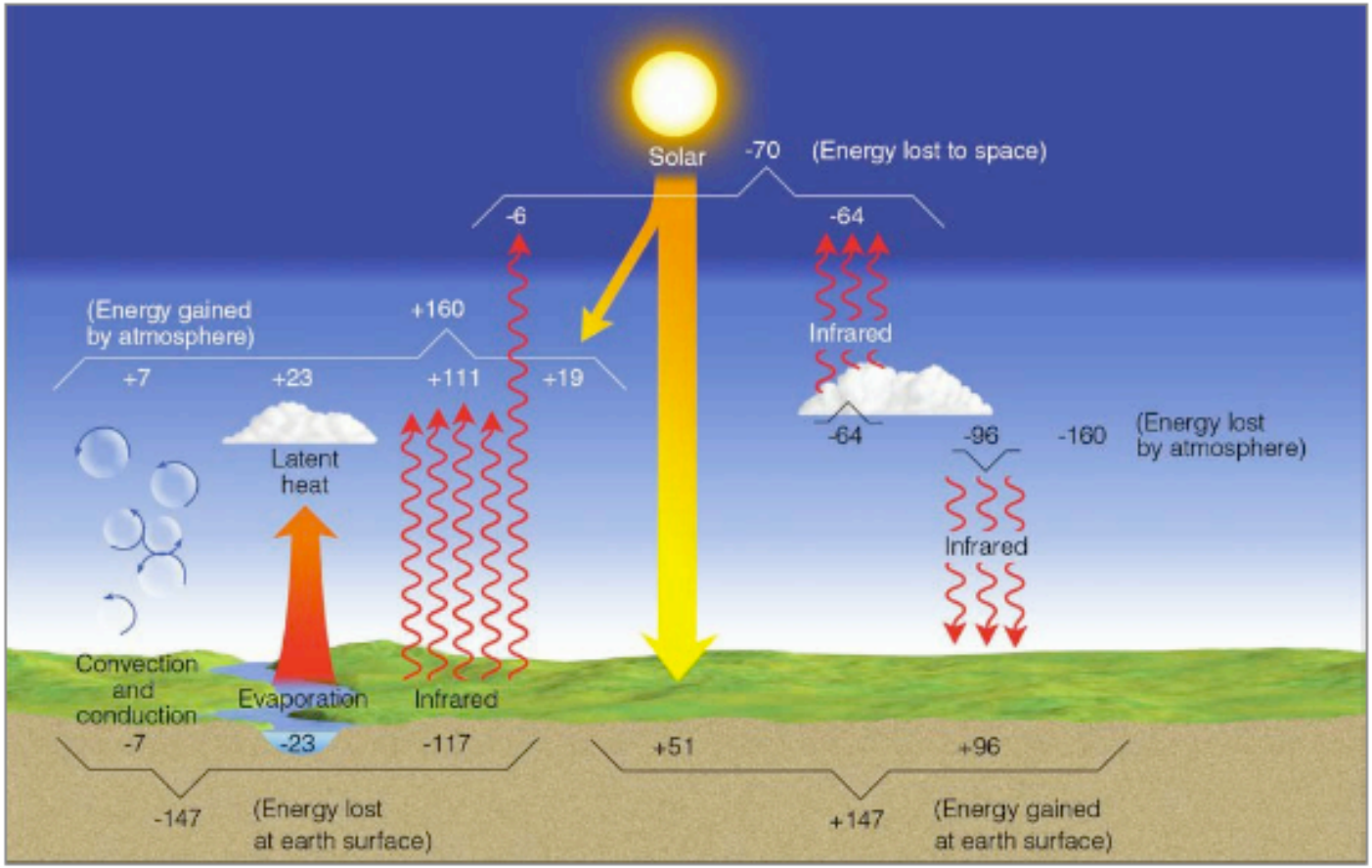
Climate System Components: Solar Radiation, Ocean, Atmosphere, Land, Snow/Ice, Vegetation

Definition of Weather and Climate

Weather: The condition of the atmosphere at any particular time and place. It is described in terms of **instantaneous** temperature, precipitation, wind speed and direction, cloudiness, and humidity.

Climate: Averaged instantaneous quantities over 'long periods of time'. Climate is described statistically in terms of mean and variance of these quantities. Usually climatological conditions are defined as averaged values over ~30 year period.

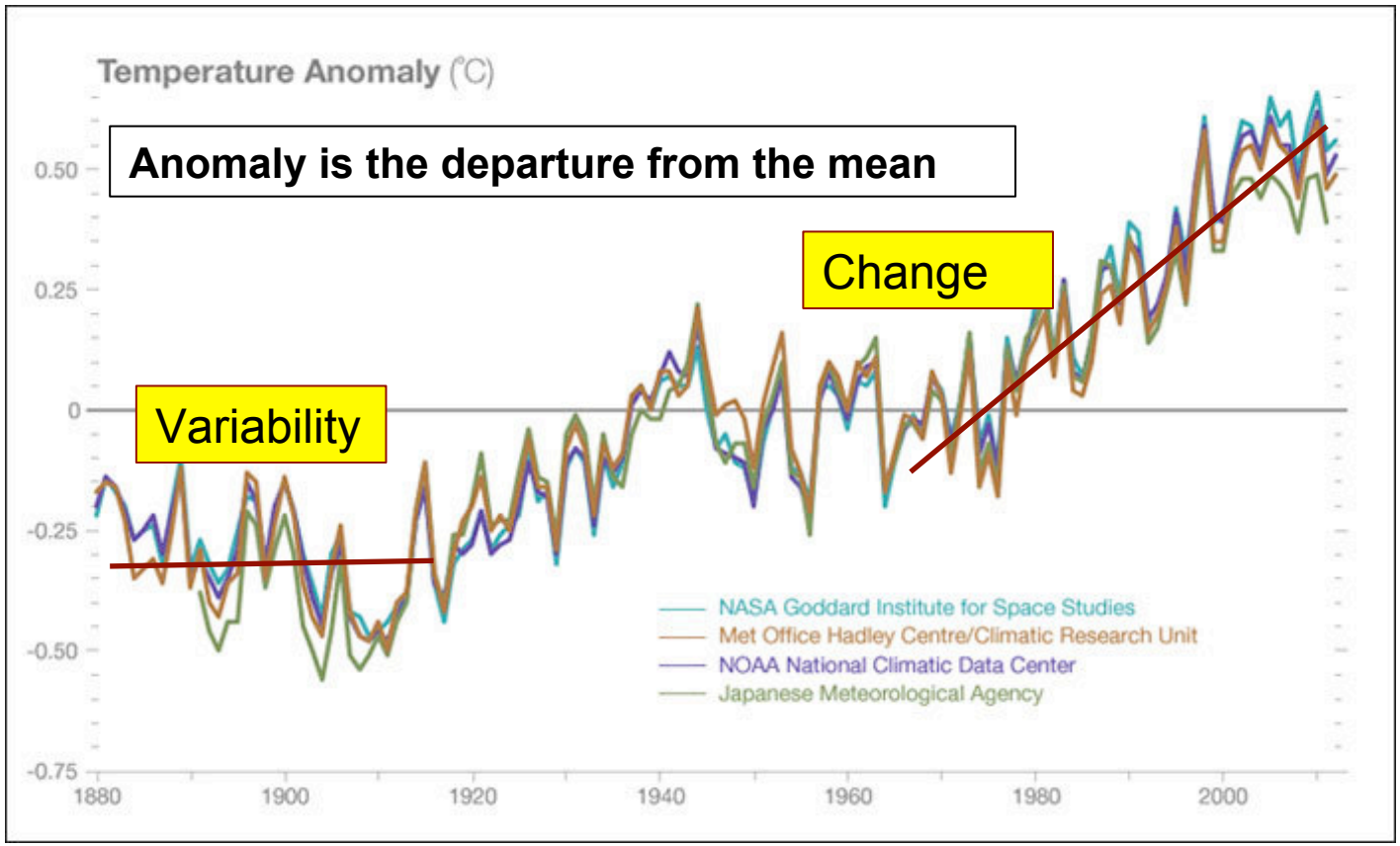
Energy Balance of the Climate System



Solar radiation, terrestrial radiation emitted to space and trapped by the greenhouse gases are the major energy components of the climate system

Climate Variability and Change

http://climate.nasa.gov/



Note that climate variability goes on whether climate is changing or not.

Climate Variability: Variance of a quantity such as surface temperature changes around the same mean

Climate Change: Mean of the quantity itself changes

Possible Causes of Climate Variability and Change

Climate Variability and Change Occur Due to Redistribution or Changes in Energy of the Climate System

Natural Climate Variability

- Changes in incoming solar radiation *[seasonal to annual variations]*
- Changes in Earth's Surface and Atmospheric Composition *[Earthquakes, Volcanoes]*
- Ocean-Atmosphere Interactions *(Inter-annual to decadal and longer)*

  [*El Niño-Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), North Atlantic Oscillation (NAO), Thermohaline Circulation]*

Anthropogenic Climate Change

Changes in Earth's Surface *[Land Use -- Deforestation, Urbanization]*

Changes in the Atmospheric Composition *[Greenhouse Gas Emissions, Air Pollution -- Industries, Transportation]*

Climate Variability and Change Impacts On Hydrologic Conditions Over South America

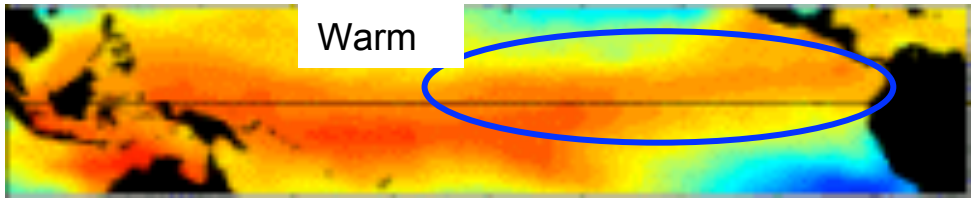
El Niño and La Niña

http://www.pmel.noaa.gov/tao/elnino/

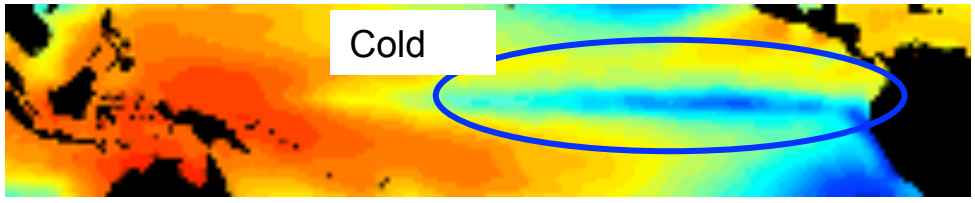
- El Niño is characterized by unusually warm ocean temperatures in the Equatorial Pacific, as opposed to La Niña, which characterized by unusually cold ocean temperatures in the Equatorial Pacific.

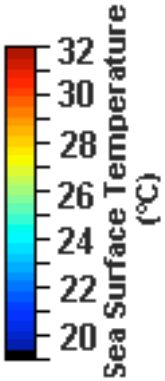
- El Niño and La Niña are oscillations of the ocean-atmosphere system in the tropical Pacific having important consequences for weather around the globe

El Niño



La Niña





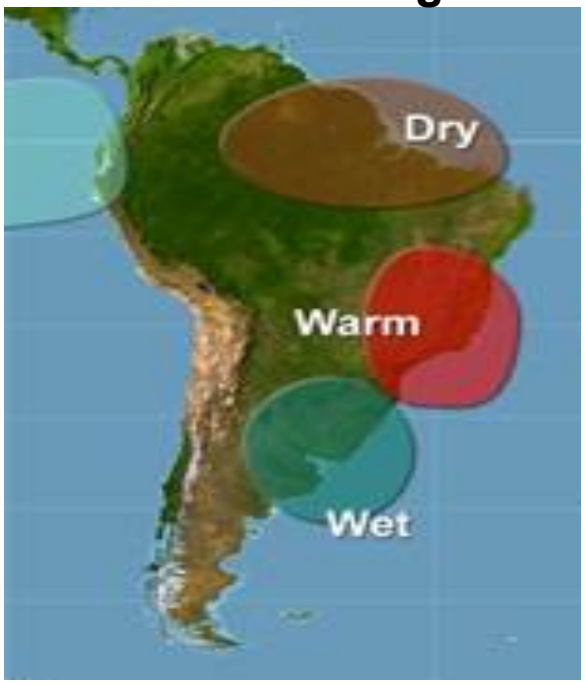
El Niño Southern Oscillation (ENSO) Impacts On South America – Temperature and Precipitation

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/impacts/warm.gif

From NOAA

Dec-Jan-Feb

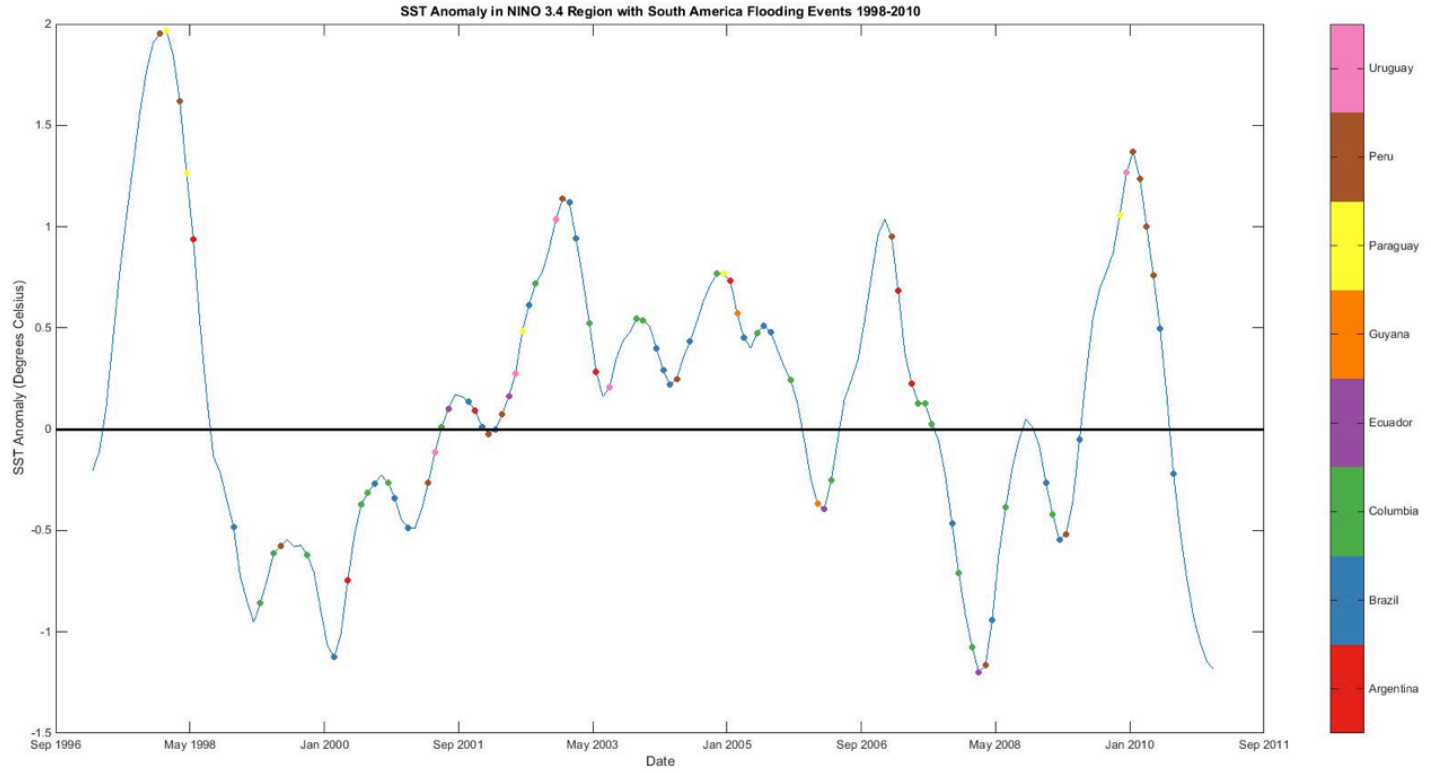
Jun-Jul-Aug



ENSO Warm Episode Impact on Temperatures and Precipitation

El Niño Southern Oscillation (ENSO) Impacts On South America - Flooding

Flood Events from Dartmouth Flood Observatory and SST anomalies from NOAA



Floods are influenced by large-scale climate conditions and local conditions

The Intergovernmental Panel on Climate Change (IPCC)
Report on Climate Variability and Change Over South America

http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap27_FINAL.pdf

Temperature and Rainfall Observed during 1950-2008:

- Warming trend in general over South America (SA) with cooling off the Chilean Coast have been observed
- Extreme temperatures have been noted over tropical and sub-tropical SA
- Increasing trend in rainfall and more extreme rain events and flooding over southeast South America (SESA) have been noted with decreasing rainfall trend in central-southern Chile

The Intergovernmental Panel on Climate Change (IPCC)
Report on Climate Variability and Change Over South America

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Temperature and Rainfall Projections in the 21st Century:

- Warming over SA varies from 1.6° C to 6.7° C for various emission scenarios
- Rainfall changes over SA vary geographically with a 22% reduction over northeast Brazil and an increase of 25% over SESA
- Increase in drying in tropical SA (east of Andes in particular), with an increase in day and night temperatures

The Intergovernmental Panel on Climate Change (IPCC)
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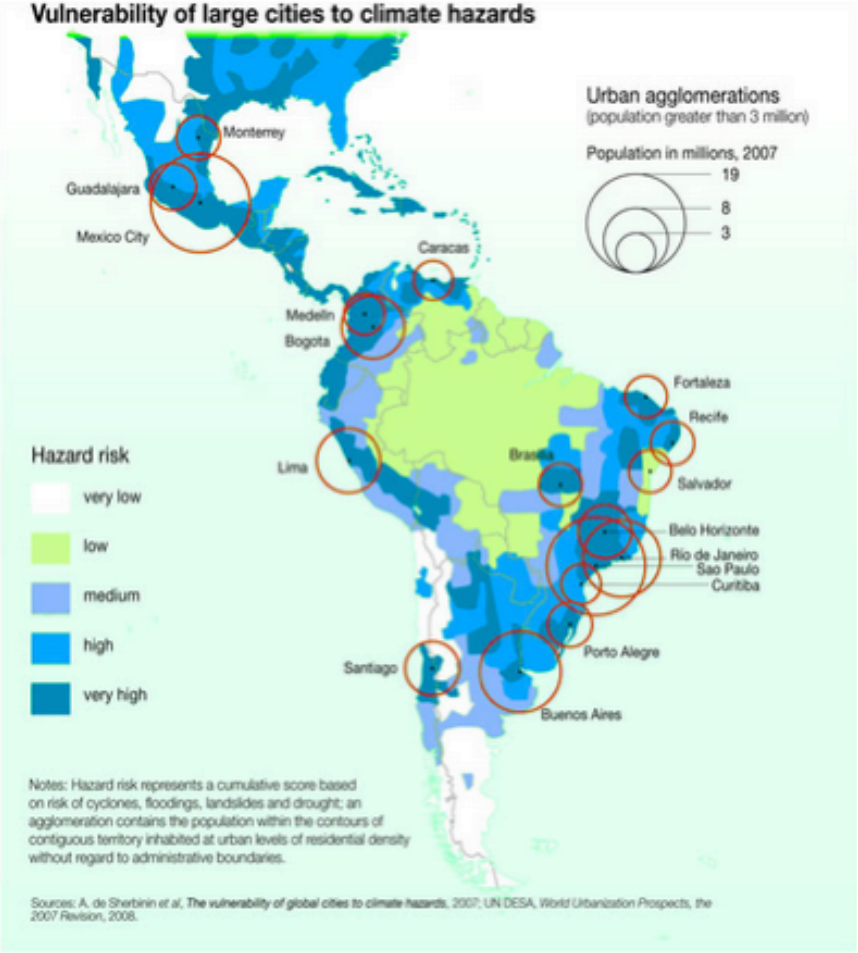
Current Observations and Future Projections show:

- The Andean cryosphere is retreating, causing changes in streamflow
- Increasing runoffs in La Plata River Basin while decreasing over the central Andes (Argentina, Chile)
- Changes in precipitation and evapotranspiration in semi-arid regions result in water shortages

Climate Variability and Change Impacts Over South America

http://www.wmo.int/bulletin/en/content/impact-climate-change-migration-and-cities-south-america

- Environmental and Ecosystem Degradation
- Impacts on Agriculture, Fishery, Economy, and Health Sectors
- Migration to Big Cities – a Major Concern



"Land use contributes significantly to environmental degradation, exacerbating the negative impacts of climate change" -- **IPCC**

How can NASA Remote Sensing Observations Help?

NASA Earth Science

http://science.nasa.gov/earth-science/

Goal:

- To understand the changing climate, its interaction with life, and how human activities affect the environment.

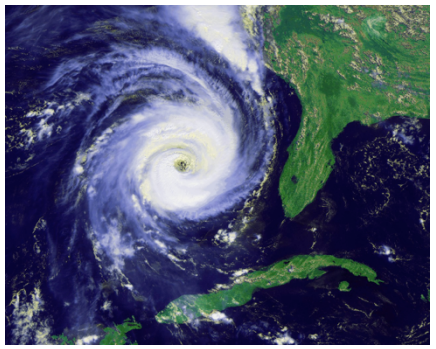
Activities:

- **Continues to lead the international scientific community to advance global integrated Earth system science using space-based observations**

- Breakthrough research to advance fundamental knowledge on the most important scientific questions about the global integrated Earth system

From Observations to Applications

Satellite Measurements



Satellite Products

Flash
Flood
Warning

Environmental Applications

NASA Earth Sciences Data

There are 6861 Unique Data Sets!

EOSDIS FY2013 Metrics (Oct. 1, 2012 to Sept. 30, 2013)	
Unique Data Sets	6,861
Distinct Users of EOSDIS Data and Services	1.7 M
Web Site Visits	2.5 M
Average Archive Growth	8.5 TB/day
Total Archive Volume	9.8 PB
End User Distribution Products	839 M
End User Average Distribution Volume	22 TB/day

EOSDIS

https://earthdata.nasa.gov/

Please Visit ARSET Webinar Page for an overview of NASA Data and Tools: http://arset.gsfc.nasa.gov/airquality-disasters-ecoforecasting-water-resources/webinars/introduction-nasa-earth-science-data

NASA Data Products Help Assess Climate Variability, Change, and Impacts Issues at Regional to Global Scales

- There are multiple sources of data archives with global, multi-year (15+ years) coverage, consistently obtained from different satellite missions/sensors
- There are data available from earth system models -- with varying features, strengths, and limitations
- Many web-based tools available for easy access, analysis, and visualization of the data
- These data are used in many weather, climate, and societal applications such as **air quality, water resources, disasters, land and ecosystems management**
- The data are **free** and publicly available

NASA Data Products Help Assess Climate Variability, Change, and Impacts Issues at Regional to Global Scales

This training will focus on:

- selected NASA data suitable for monitoring seasonal to inter-annual climate variability and its impacts on hydrology parameters (primarily temperature, precipitation) and flooding
- selected data and web-tools for monitoring **near-real time** flooding conditions over south America

Next Presentation:

Fundamentals of Remote Sensing